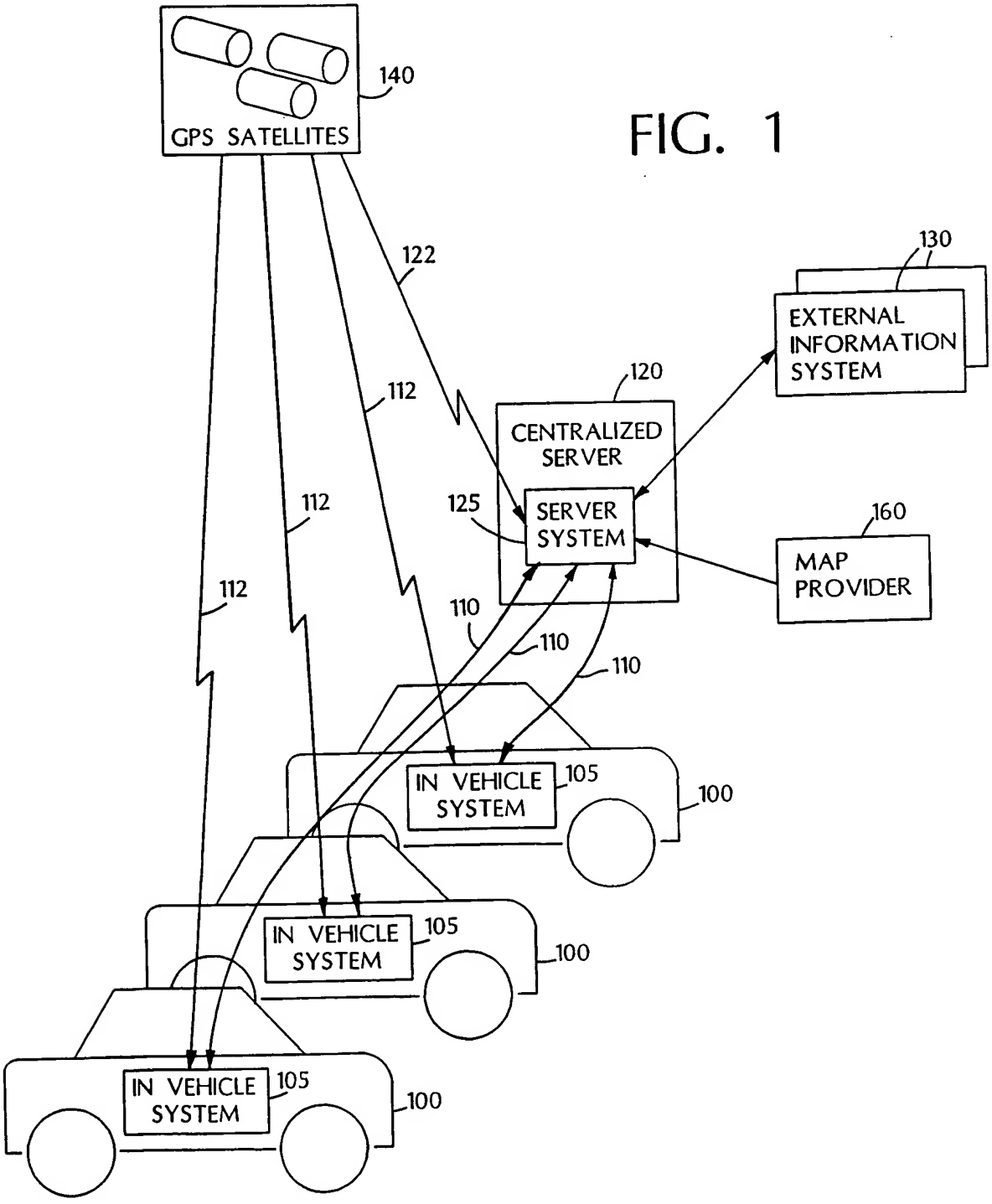

GPS SATELLITES
140
122
112
112
112
130
EXTERNAL INFORMATION SYSTEM
120
CENTRALIZED SERVER
125
SERVER SYSTEM
160
MAP PROVIDER
110
110
110
IN VEHICLE SYSTEM
105
100
IN VEHICLE SYSTEM
105
100
IN VEHICLE SYSTEM
105
100

FIG. 1

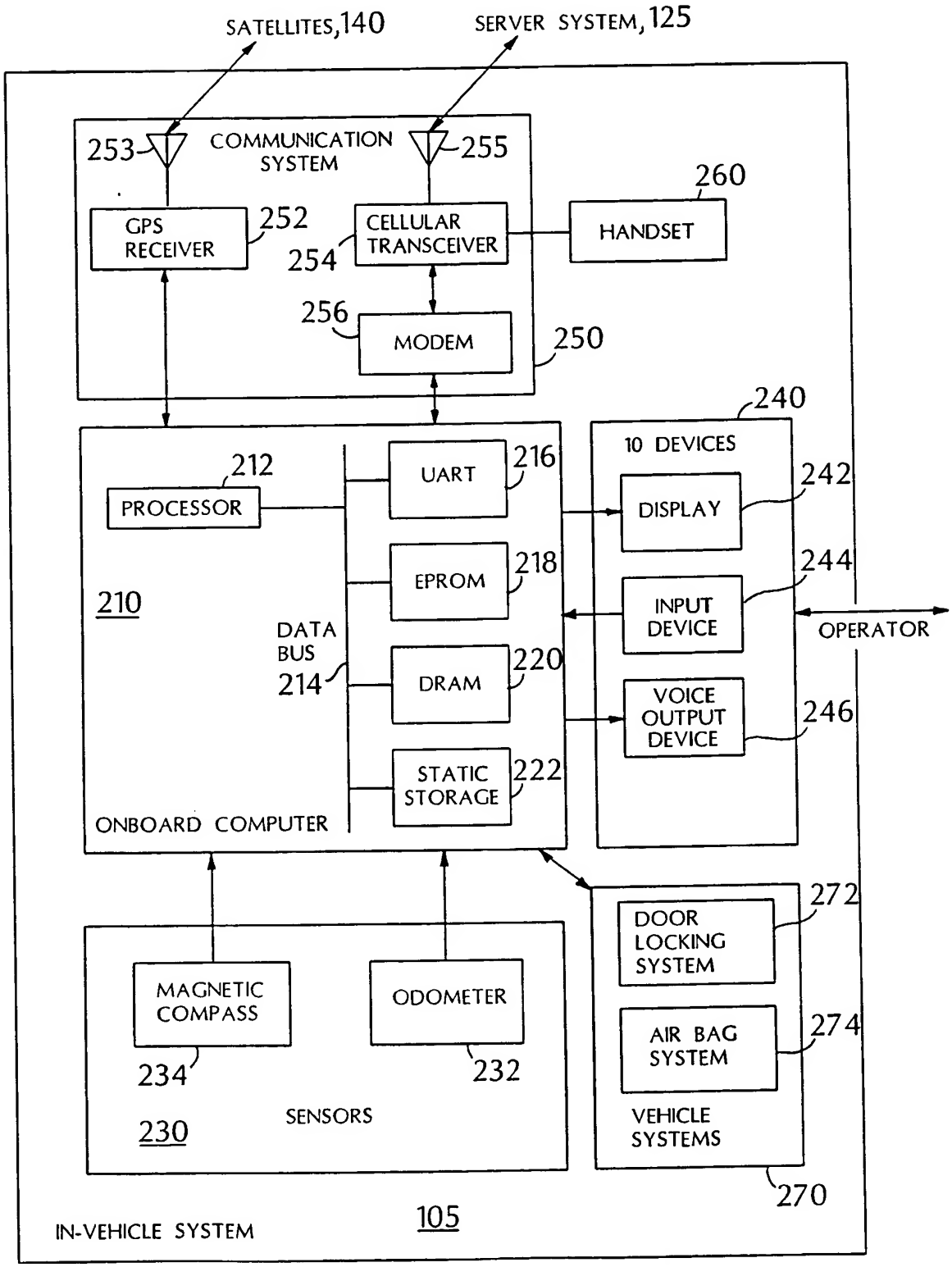

SATELLITES, 140
SERVER SYSTEM, 125
253
COMMUNICATION SYSTEM
255
260
GPS RECEIVER
252
254
CELLULAR TRANSCEIVER
HANDSET
256
MODEM
250
240
10 DEVICES
212
PROCESSOR
UART
216
242
DISPLAY
EPROM
218
244
210
INPUT DEVICE
OPERATOR
DATA BUS
214
DRAM
220
VOICE OUTPUT DEVICE
246
STATIC STORAGE
222
ONBOARD COMPUTER
272
DOOR LOCKING SYSTEM
MAGNETIC COMPASS
ODOMETER
AIR BAG SYSTEM
274
234
232
SENSORS
230
VEHICLE SYSTEMS
270
IN-VEHICLE SYSTEM
105

FIG. 2

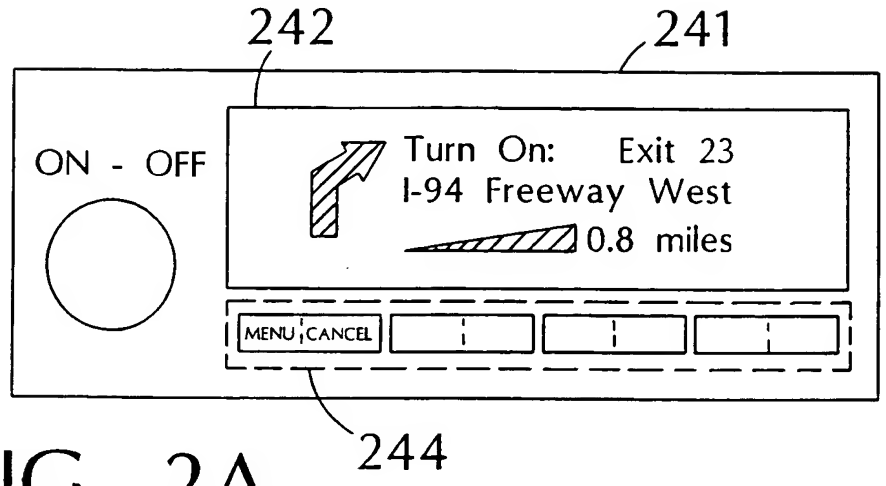


FIG. 2A

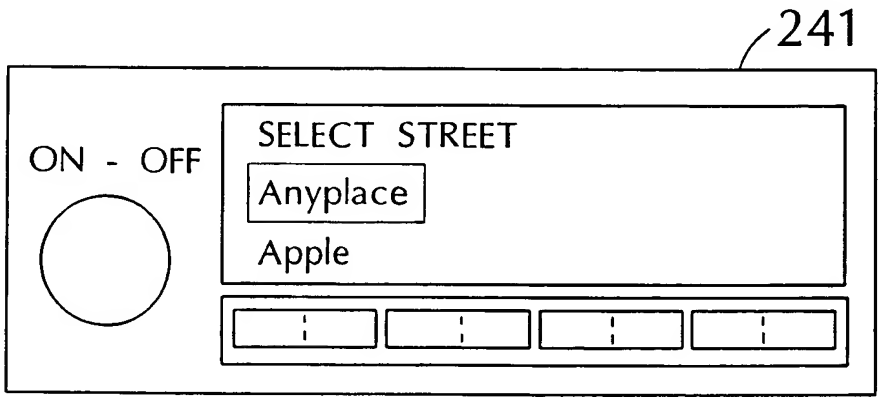


FIG. 2B

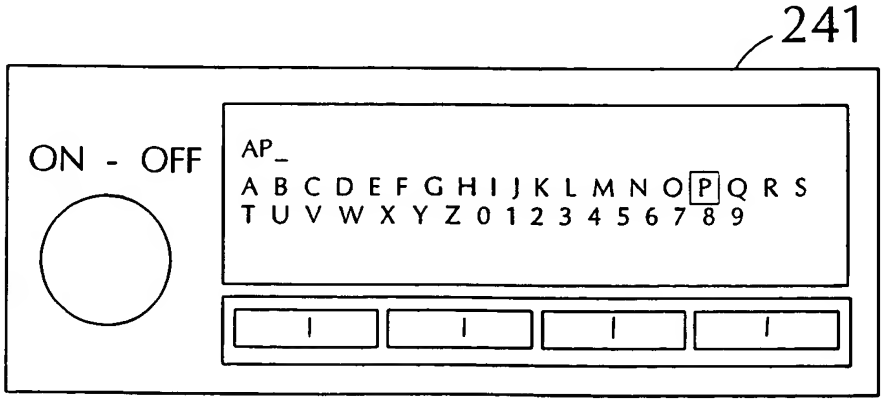


FIG. 2C

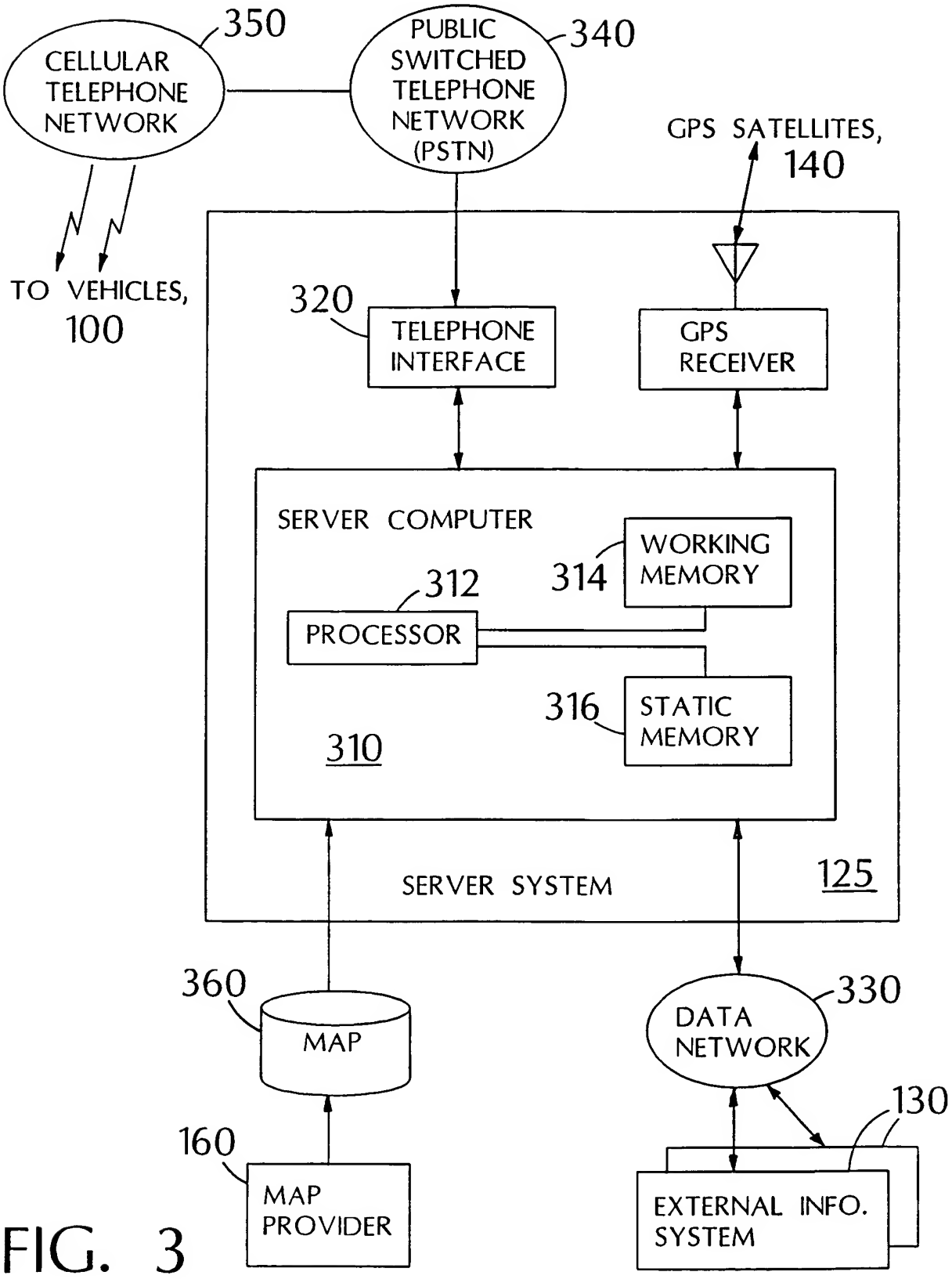

CELLULAR TELEPHONE NETWORK
350
PUBLIC SWITCHED TELEPHONE NETWORK (PSTN)
340
GPS SATELLITES, 140
TO VEHICLES, 100
320
TELEPHONE INTERFACE
GPS RECEIVER
SERVER COMPUTER
WORKING MEMORY
314
312
PROCESSOR
316
STATIC MEMORY
310
SERVER SYSTEM
125
360
MAP
DATA NETWORK
330
130
160
MAP PROVIDER
EXTERNAL INFO. SYSTEM

FIG. 3

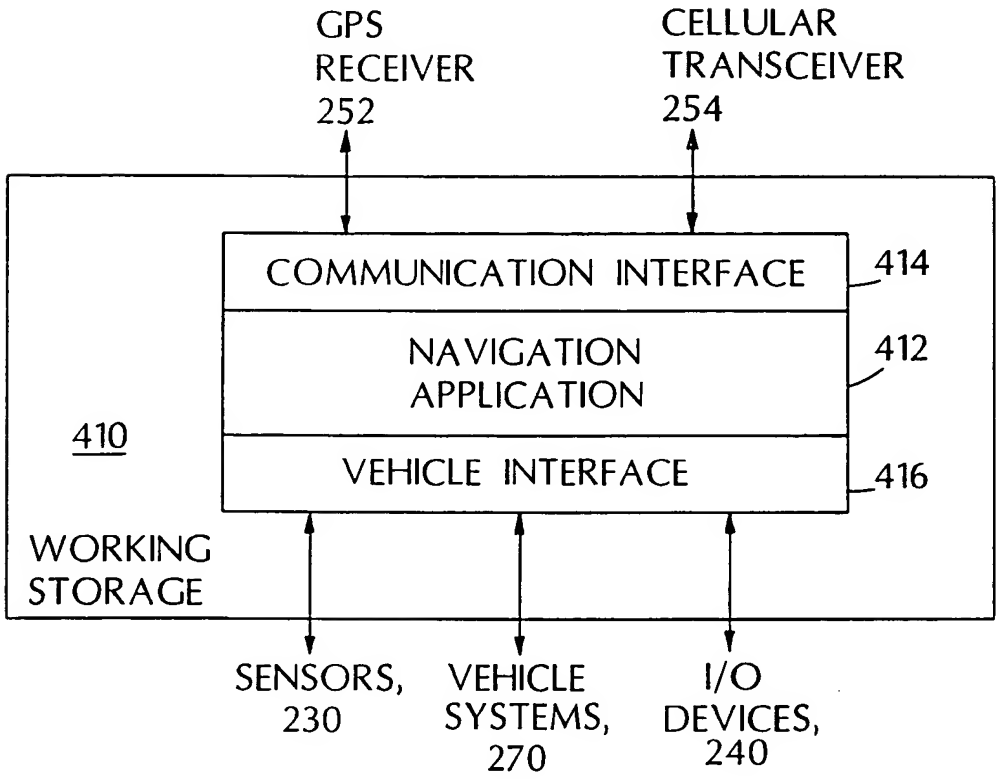

GPS
RECEIVER
252
CELLULAR
TRANSCEIVER
254
COMMUNICATION INTERFACE
414
NAVIGATION
APPLICATION
412
410
VEHICLE INTERFACE
416
WORKING
STORAGE
SENSORS,
230
VEHICLE
SYSTEMS,
270
I/O
DEVICES,
240

FIG. 4A

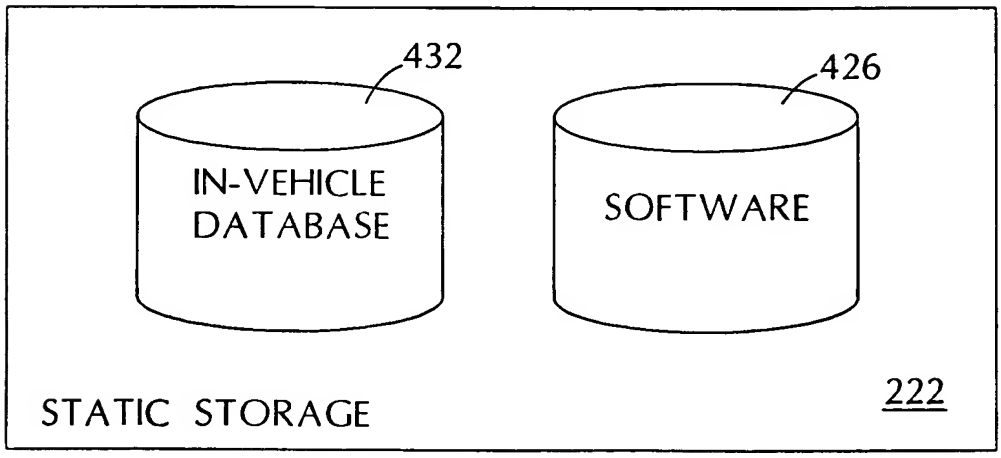

432
426
IN-VEHICLE
DATABASE
SOFTWARE
STATIC STORAGE
222

FIG. 4B

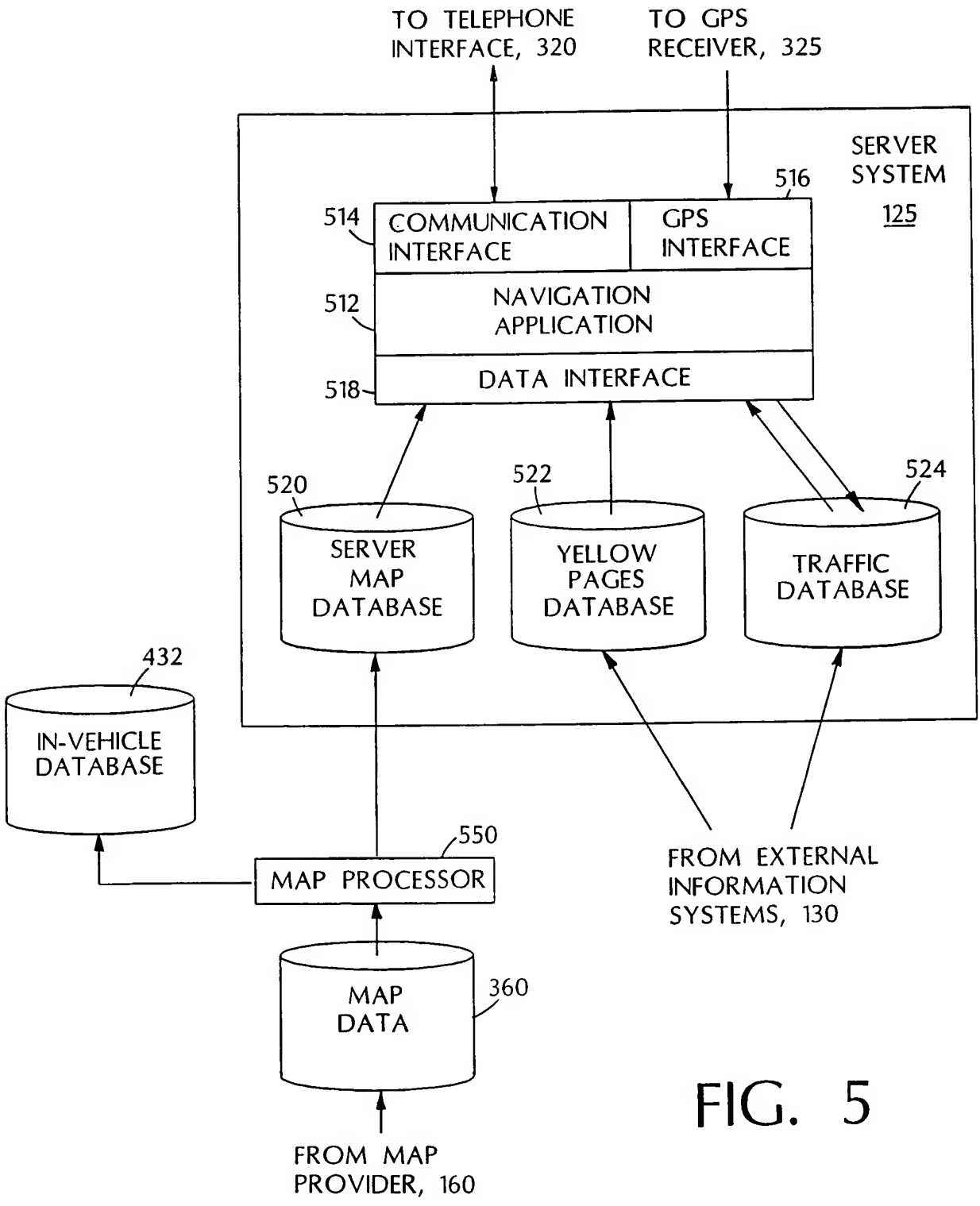

TO TELEPHONE INTERFACE, 320
TO GPS RECEIVER, 325
SERVER SYSTEM
125
516
514
COMMUNICATION INTERFACE
GPS INTERFACE
512
NAVIGATION APPLICATION
518
DATA INTERFACE
520
522
524
SERVER MAP DATABASE
YELLOW PAGES DATABASE
TRAFFIC DATABASE
432
IN-VEHICLE DATABASE
550
MAP PROCESSOR
FROM EXTERNAL INFORMATION SYSTEMS, 130
MAP DATA
360
FROM MAP PROVIDER, 160

FIG. 5

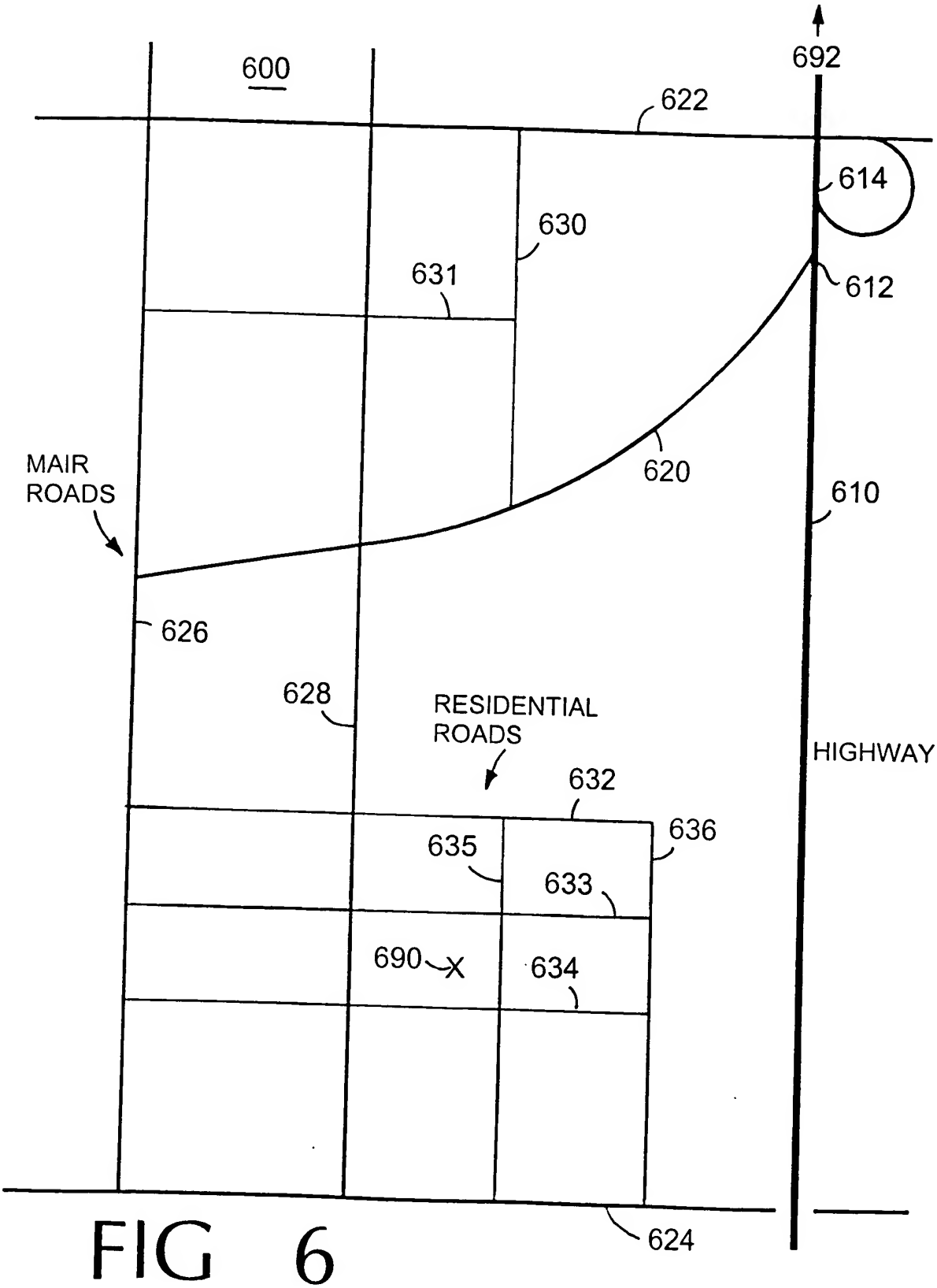

600
692
622
614
630
631
612
MAIR
ROADS
620
610
626
628
RESIDENTIAL
ROADS
HIGHWAY
632
636
635
633
690
634
624

FIG 6

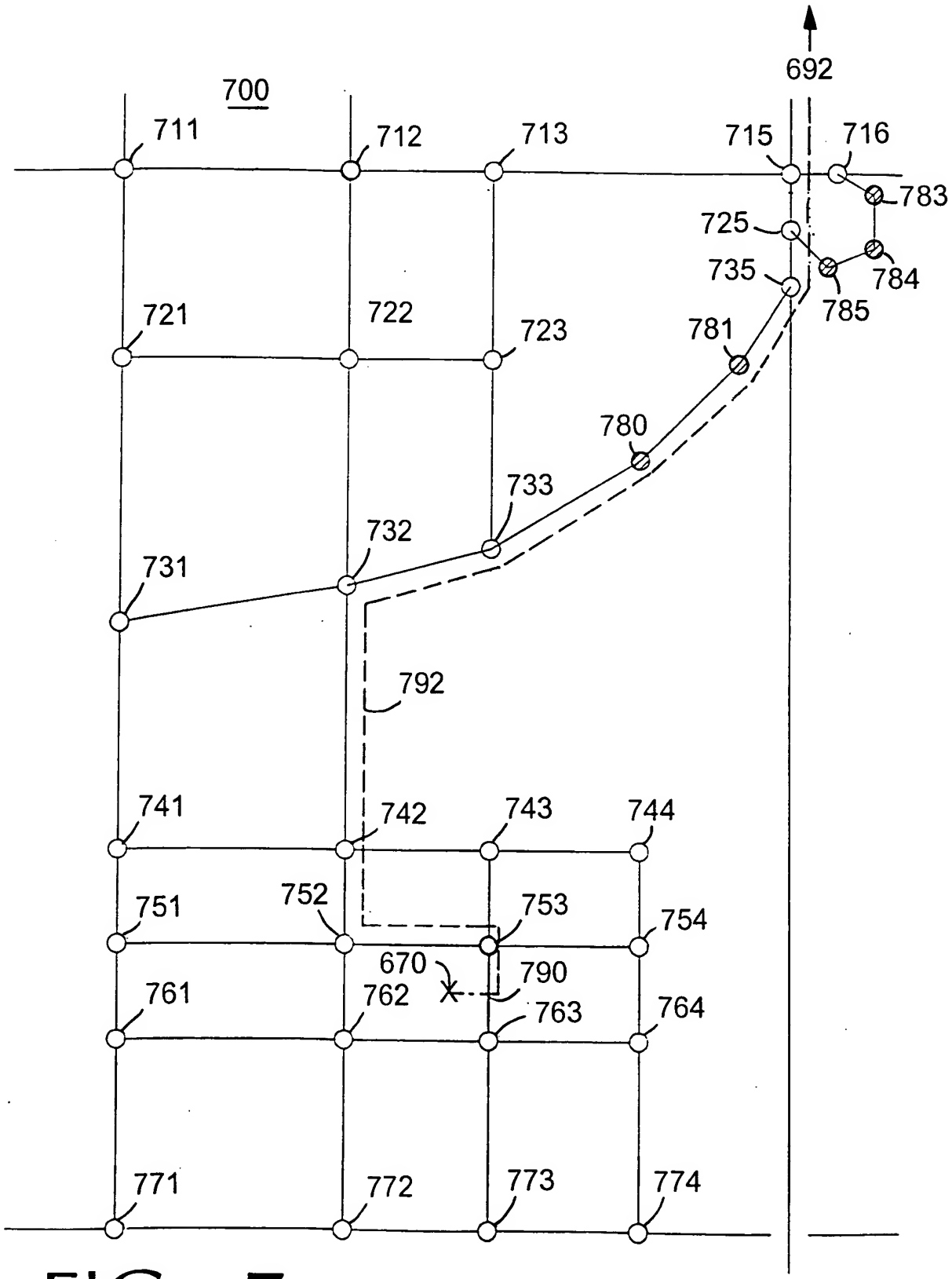

692
700
711
712
713
715
716
783
725
735
784
785
721
722
723
781
780
733
732
731
792
741
742
743
744
751
752
753
754
670
790
761
762
763
764
771
772
773
774

FIG. 7

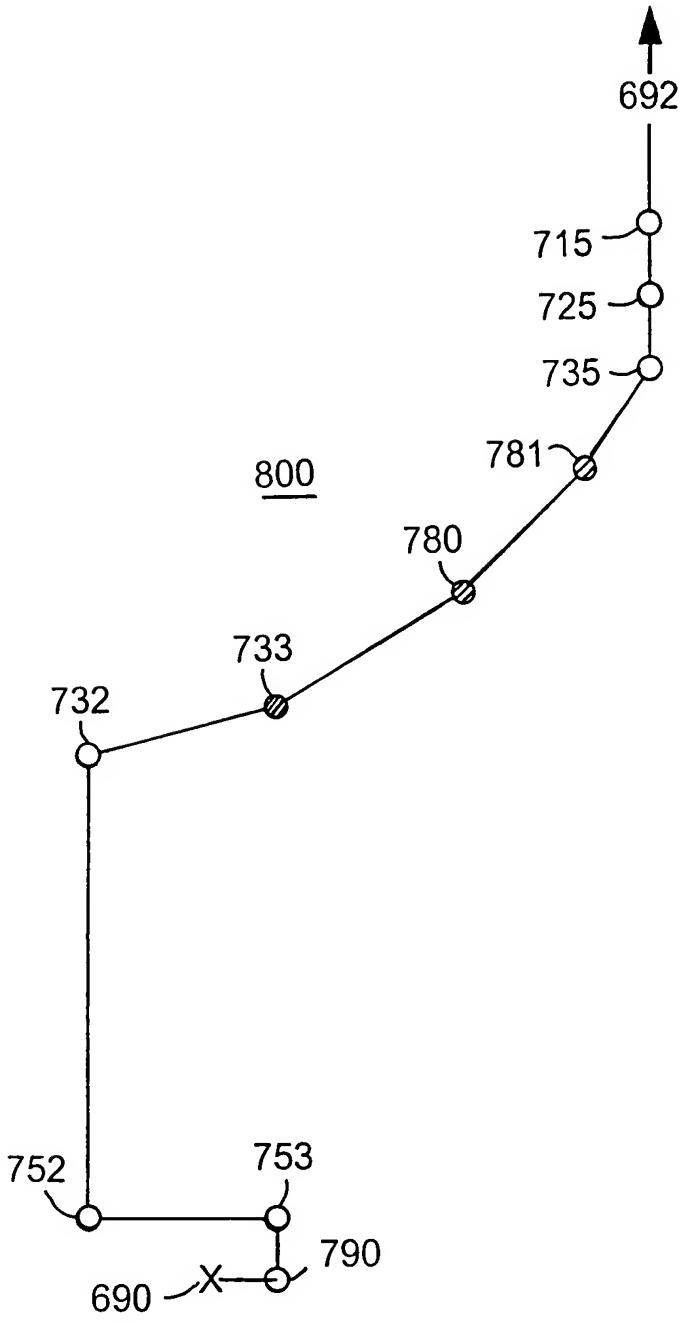
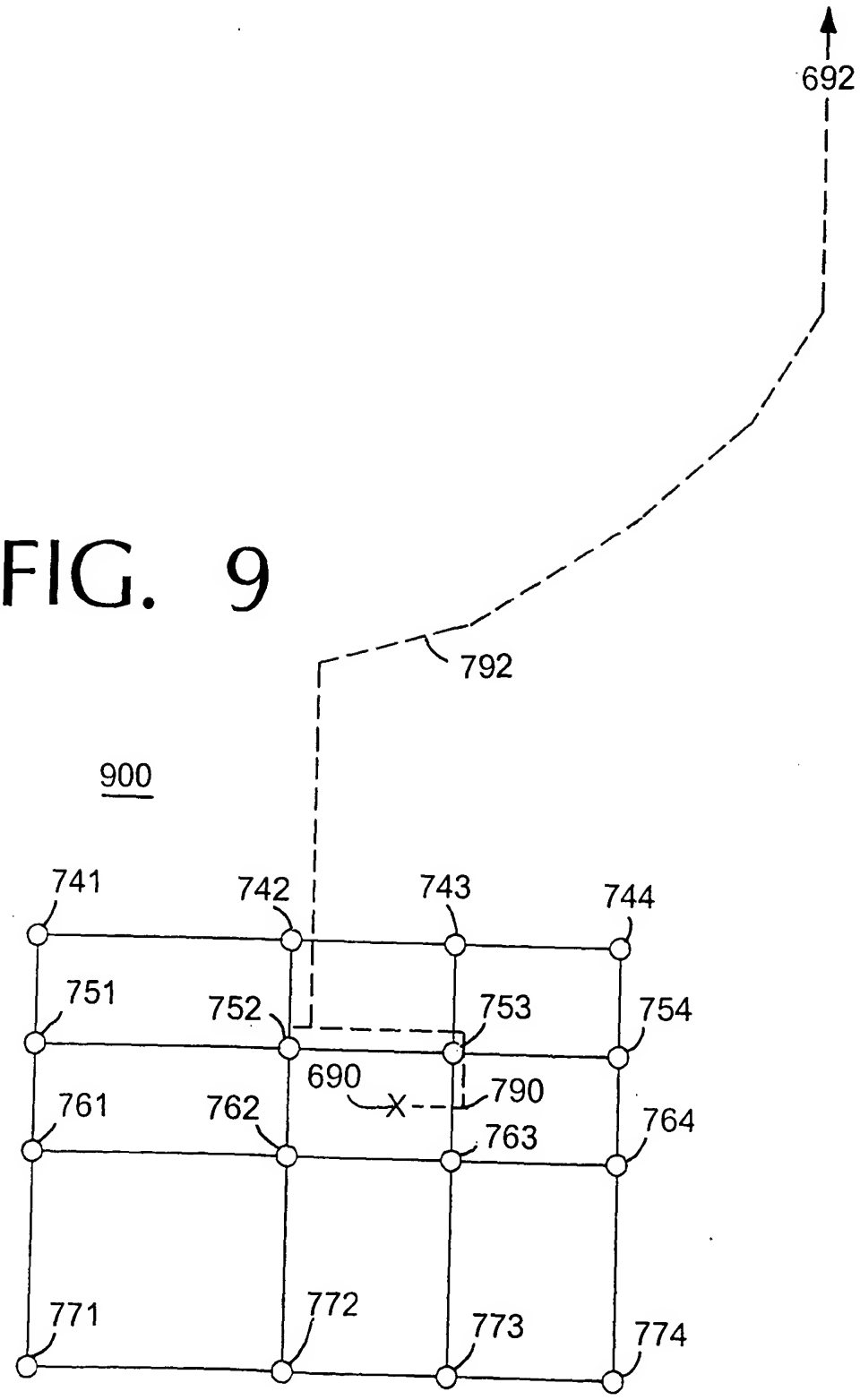


FIG 8

FIG. 9


692
792
900
741
742
743
744
751
752
753
754
690
790
761
762
763
764
771
772
773
774

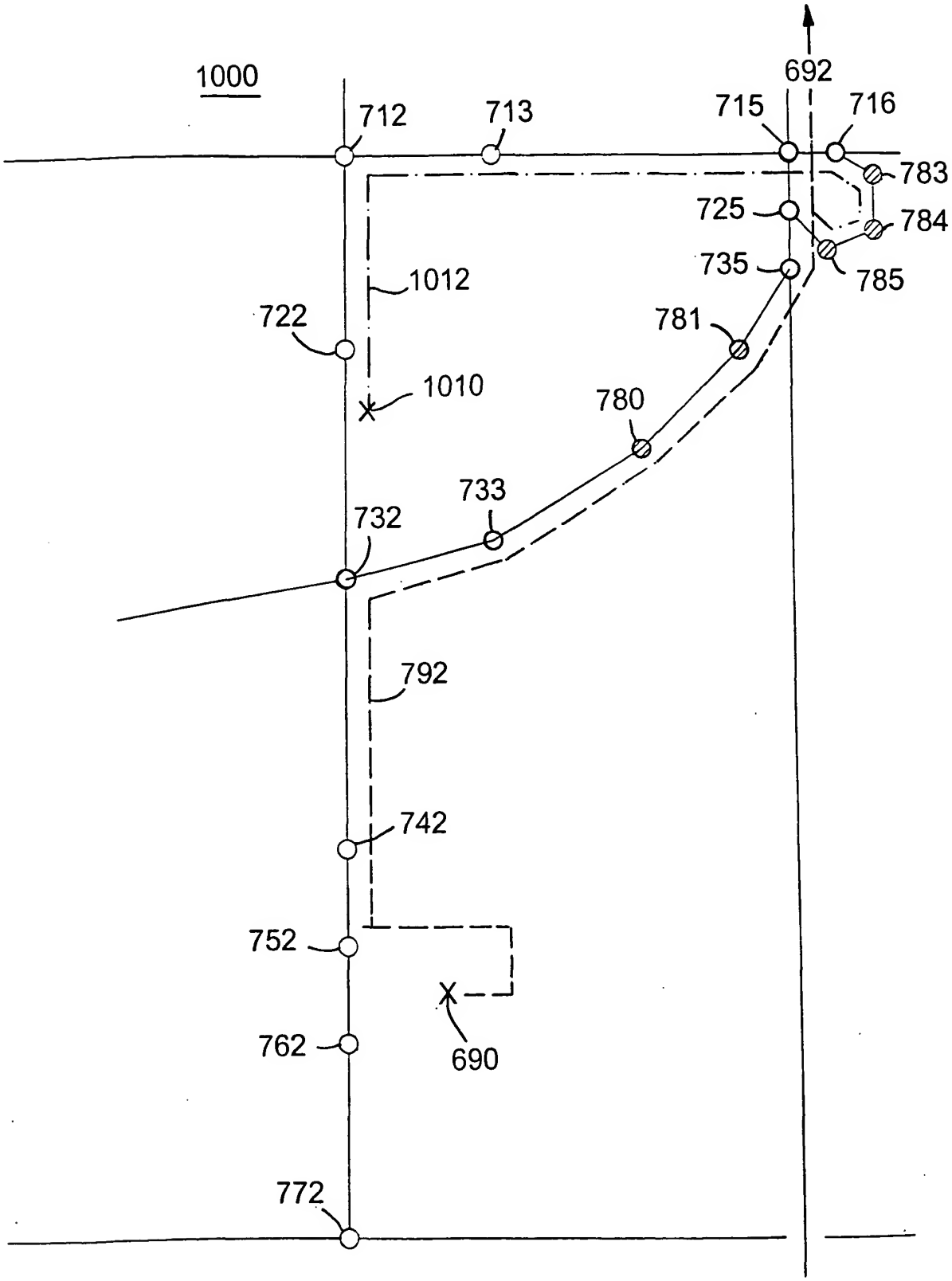

1000
712
713
715
716
692
783
725
784
735
785
1012
722
781
1010
780
733
732
792
742
752
762
690
772

FIG. 10

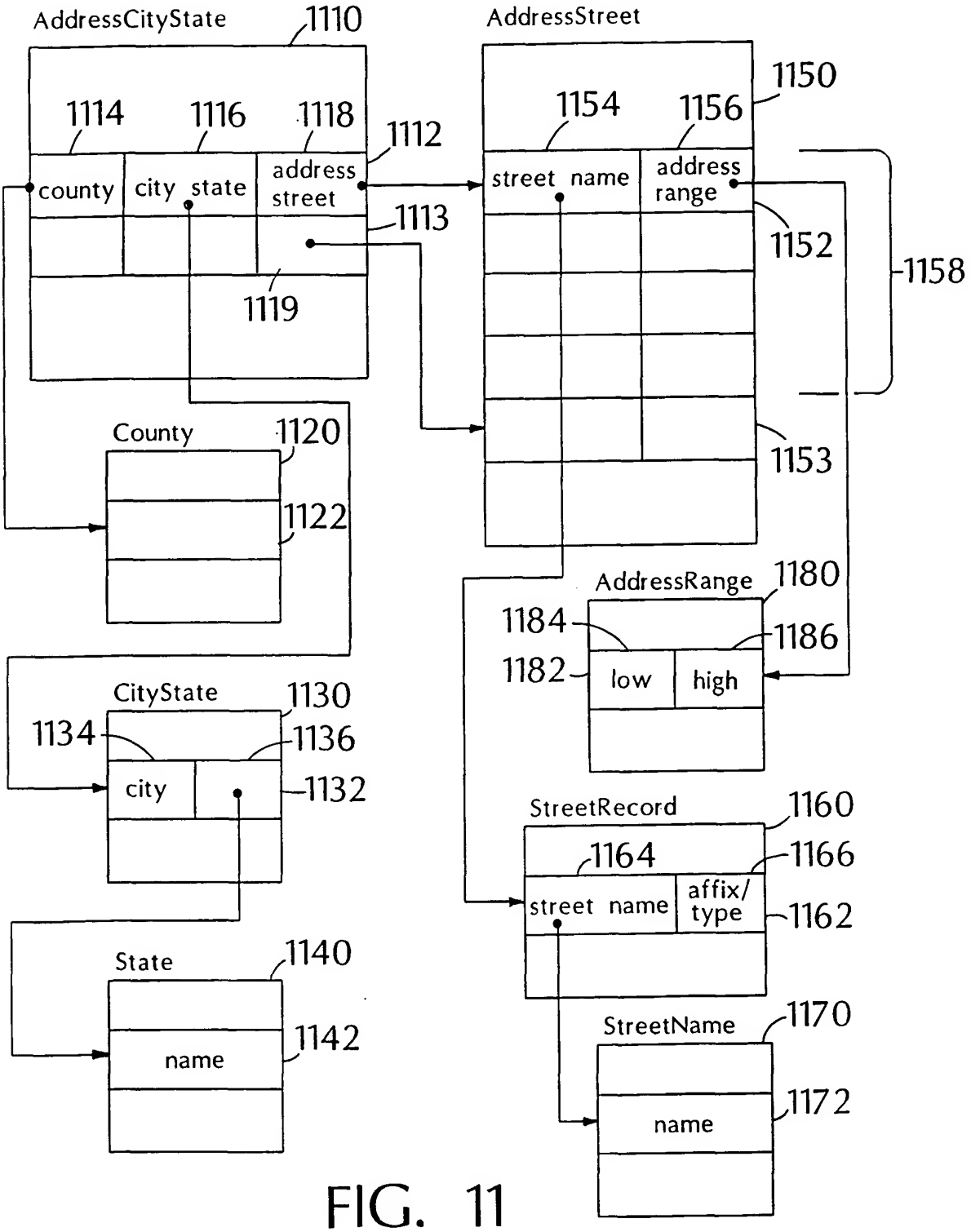

AddressCityState
1110
1114
1116
1118
1112
county
city
state
address street
1113
1119
AddressStreet
1150
1154
1156
street name
address range
1152
1158
1153
County
1120
1122
AddressRange
1180
1184
1186
1182
low
high
CityState
1130
1134
1136
city
1132
StreetRecord
1160
1164
1166
street name
affix/ type
1162
State
1140
name
1142
StreetName
1170
name
1172

FIG. 11

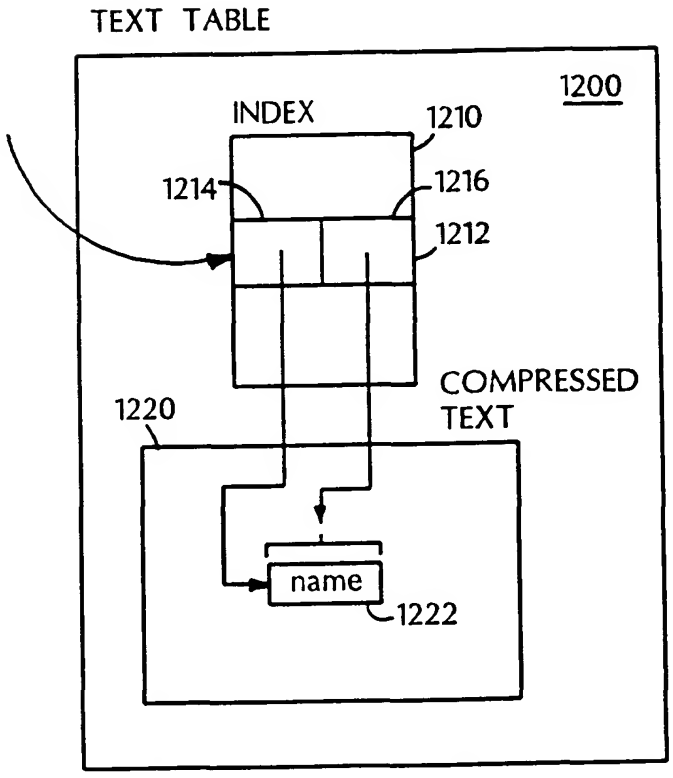

TEXT TABLE
1200
INDEX
1210
1214
1216
1212
COMPRESSED
TEXT
1220
name
1222

FIG. 12

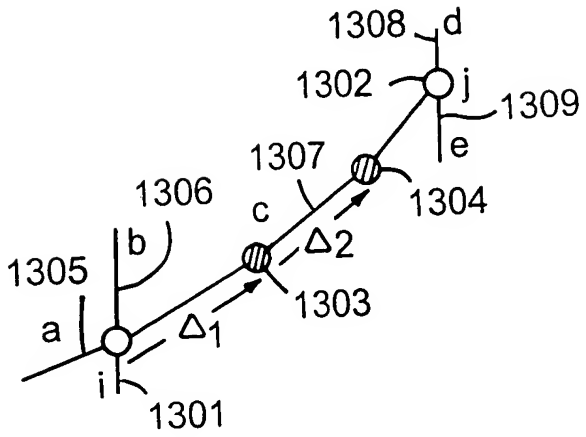


FIG. 13A

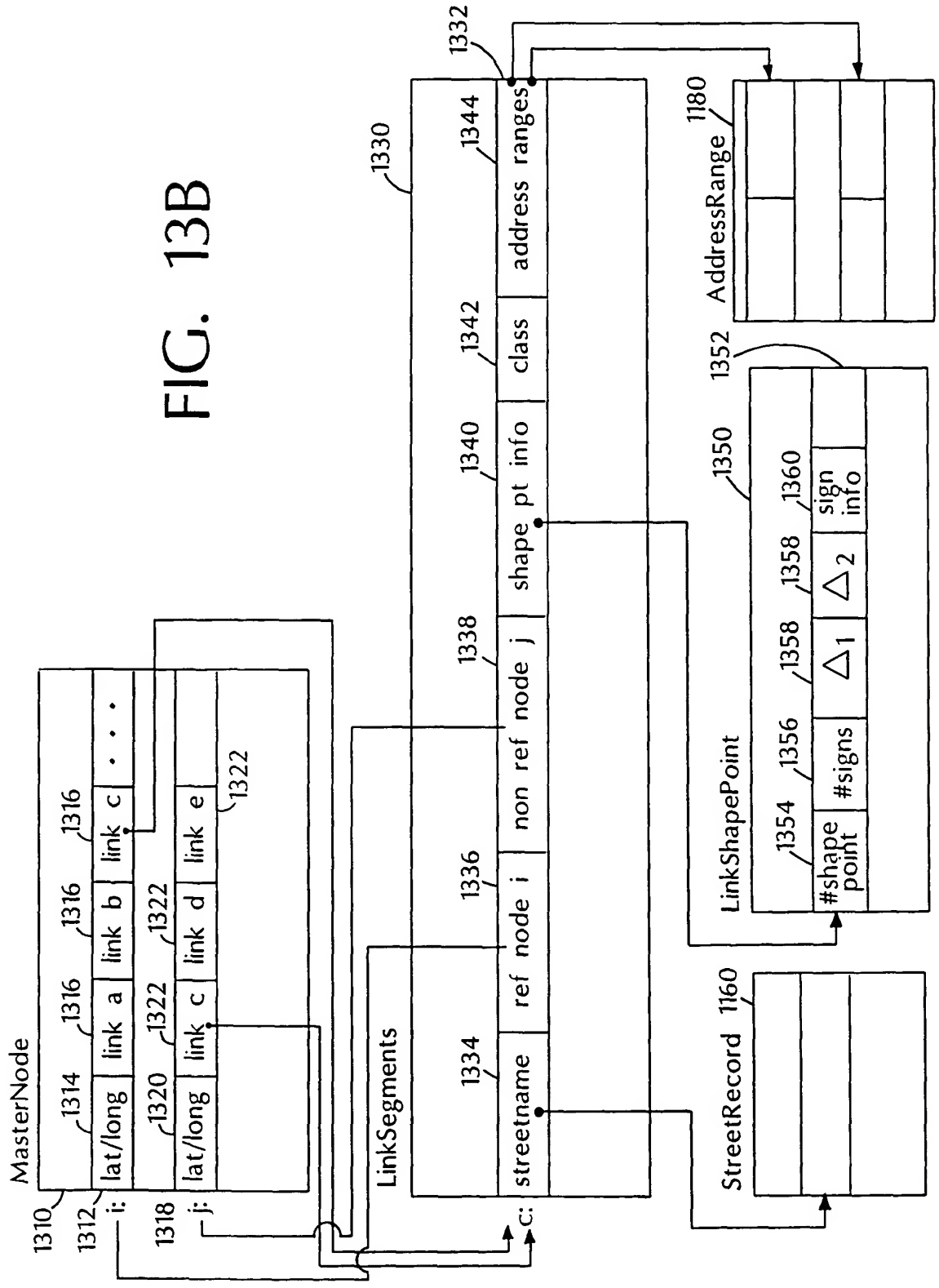

MasterNode
1310
1312
i:
1314
lat/long
1316
link a
1316
link b
1316
link c
1316
• • •
1318
j:
1320
lat/long
1322
link c
1322
link d
link e
1322
LinkSegments
1330
1332
1334
streetname
ref node i
1336
non ref node j
1338
shape pt info
1340
class
1342
address ranges
1344
c:
AddressRange
1180
StreetRecord
1160
LinkShapePoint
1350
1352
#shape point
1354
#signs
1356
Δ1
1358
Δ2
1358
sign info
1360

FIG. 13B

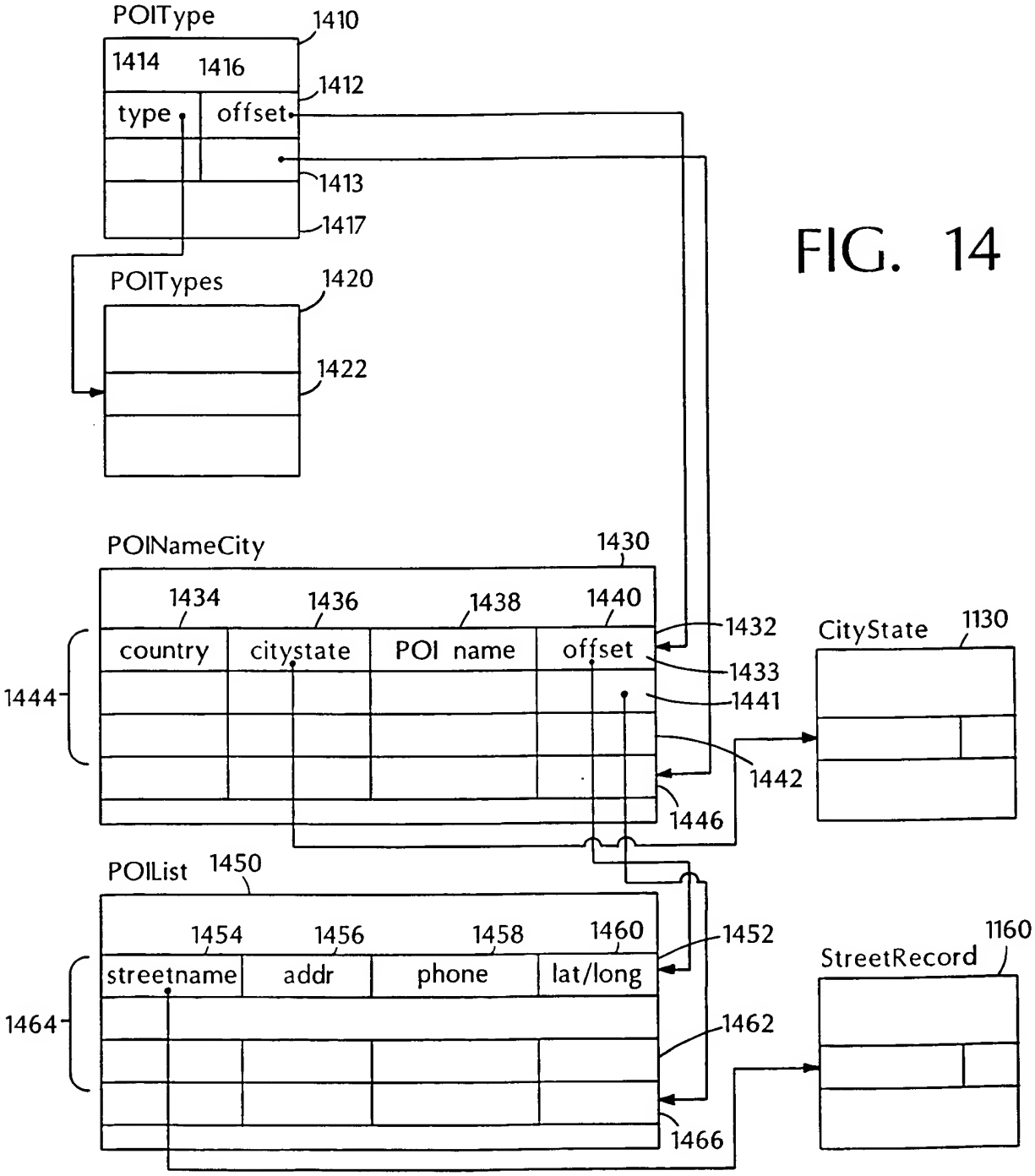

POIType
1410
1414
1416
1412
type
offset
1413
1417
POITypes
1420
1422
POINameCity
1430
1434
1436
1438
1440
1432
country
citystate
POI name
offset
1433
1441
1444
1442
1446
CityState
1130
POIList
1450
1454
1456
1458
1460
1452
streetname
addr
phone
lat/long
1464
1462
1466
StreetRecord
1160

FIG. 14

1501 **Plan Route (In-Vehicle):**

1502 Accept Destination Specification from Operator

1503 Determine Current Location Data

1504 Establish Communication Session with Server

1505 Send Destination Specification and Current Location Data to Server

1506 IF Destination Specification Requires Server Interaction THEN

1507 Accept Secondary Destination Specification Data from Server

1508 Accept Secondary Destination Specification from Operator

1509 Send Secondary Destination Specification to Server

1510 END IF

1511 Wait for Server Response

1512 Receive Planned Route, Spot Map, and Differential GPS Data from Server

1513 Close Communication Session with Server

FIG. 15A

1551 **Plan Route (Server):**

1552 Accept Communication Session with Vehicle

1553 Receive Destination Specification and Current Location Data from Vehicle

1554 Determine DGPS Correction Data

1555 Determine Vehicle Location

1556 IF Destination Specification Requires Further Operator Input THEN

1557 Determine Secondary Destination Specification Data

1558 Send Secondary Destination Specification Data to Vehicle

1559 Receive Secondary Destination Specification from Vehicle

1560 END IF

1561 Determine Planned Route to Specified Destination

1562 Determine Spot Map near Vehicle Location

1563 Send Planned Route, Spot Map, and DGPS Data to Vehicle

1564 Close Communication Session with Vehicle

FIG. 15B

1601 **Startup Maneuvers:**

1602 Initialize Estimated Location using Differential GPS Data
1603 WHILE Estimated Location is not at a Point of the Planned Route DO
1604 Track Estimated Location using (D)GPS Data
1605 Display Spot Map and Estimated Location on Display
1606 END WHILE

FIG. 16

1801 **Replan Route:**

1802 Estimate Vehicle Location of Main Roads Network using
1803 Dead-Reconing Location
1804 Calculate Best Route to a Maneuver or Way Point on the Previous
1805 Planned Route
1806 Replace Planned Route with Newly Calculated Route
1807 GOTO Follow Route

FIG. 18

```
1701  Follow Route:
1702  FOR Each Link on Planned Route DO
1703      At Initial Maneuver Initialize Off-Route Tolerance
1704      WHILE Vehicle Is Travelling to the Next Maneuver Point DO
1705          Increase Off-Route Tolerance
1706          Track Dead-Reckoning Location
1707          Track (D)GPS Location
1708          IF (Dead-Reckoning Location is more than Off-Route Tolerance
1709                  from (D)GPS Location THEN
1710              GOTO Replan Route
1711          END IF
1712          IF Dead-Reckoning Location is within Maneuver
1713                  Notification Window THEN
1714              Notify Operator of Next Maneuver
1715          END IF
1716          IF Dead-Reckoning Location is within Maneuver
1717                  Detection Window THEN
1718              IF Next Maneuver is Detected THEN
1719                  Update Dead-Reckoning Location
1720                  Update DGPS Data
1721              END IF
1722          END IF
1723      UNTIL Maneuver was Detected OR
1724              Vehicle Leaves Maneuver Detection Window
1725  UNTIL Destination is Reached
```

FIG. 17

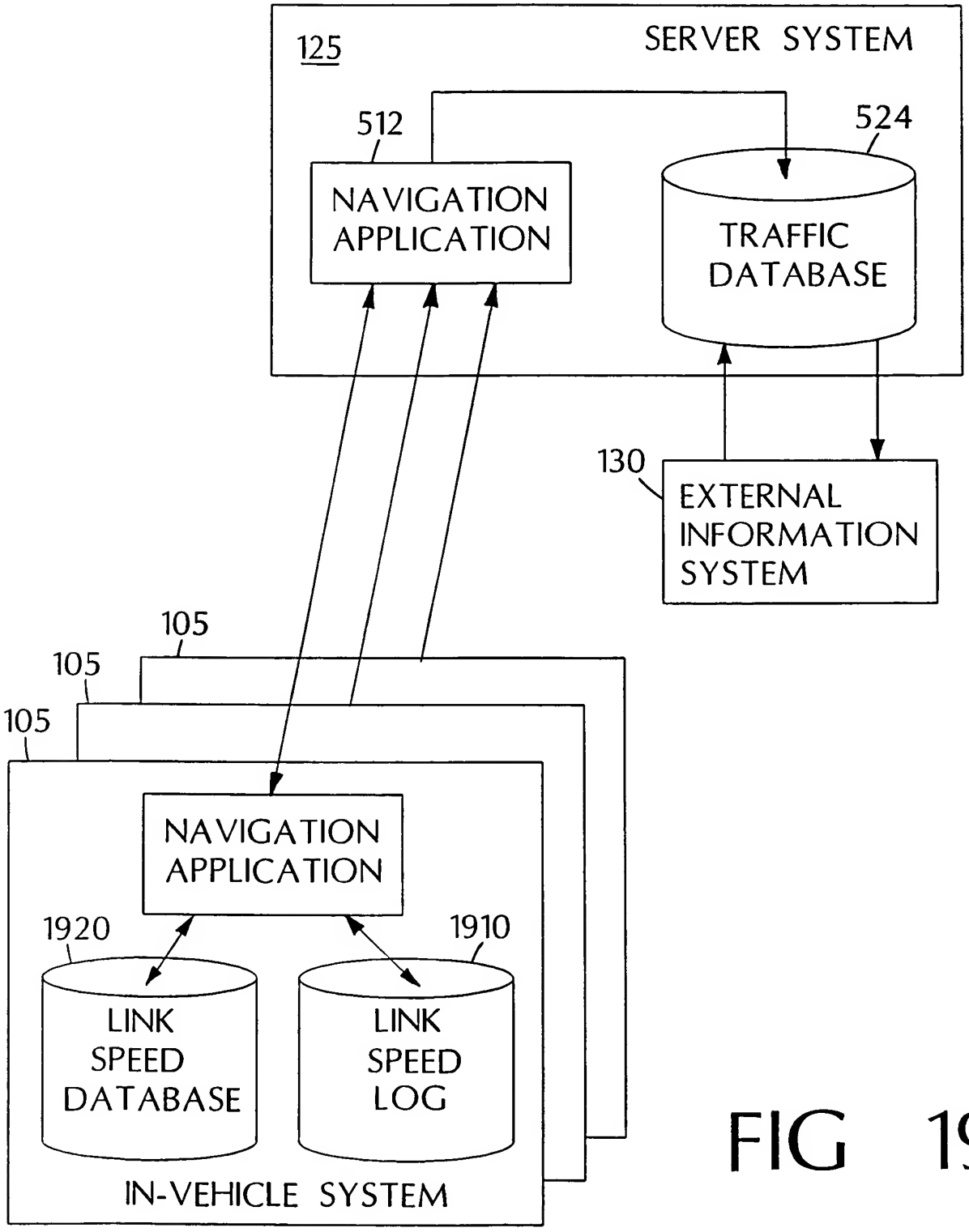

125
SERVER SYSTEM
512
NAVIGATION APPLICATION
524
TRAFFIC DATABASE
130
EXTERNAL INFORMATION SYSTEM
105
105
105
NAVIGATION APPLICATION
1920
1910
LINK SPEED DATABASE
LINK SPEED LOG
IN-VEHICLE SYSTEM

FIG 19

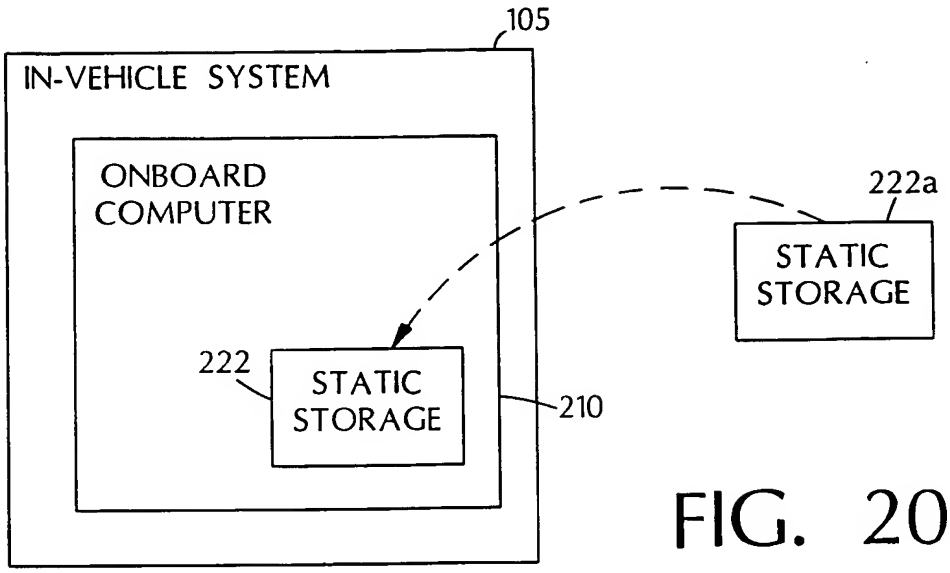


FIG. 20A

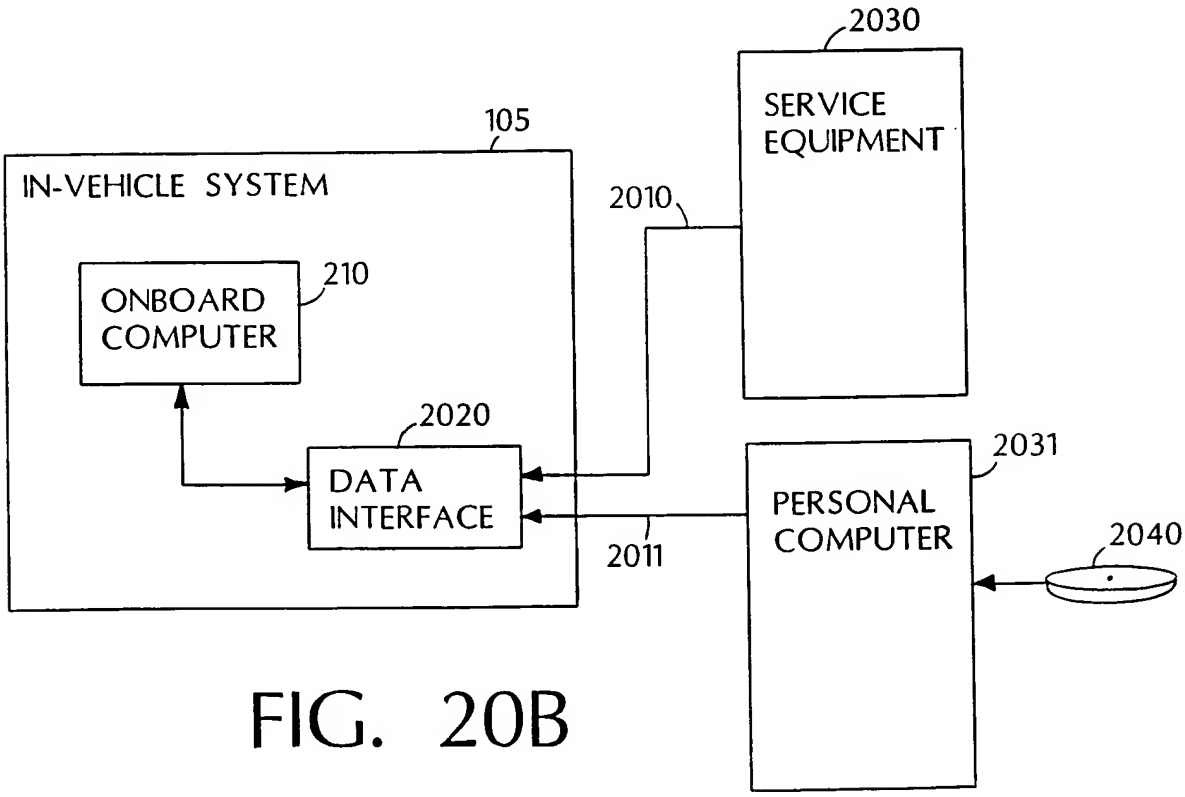


FIG. 20B

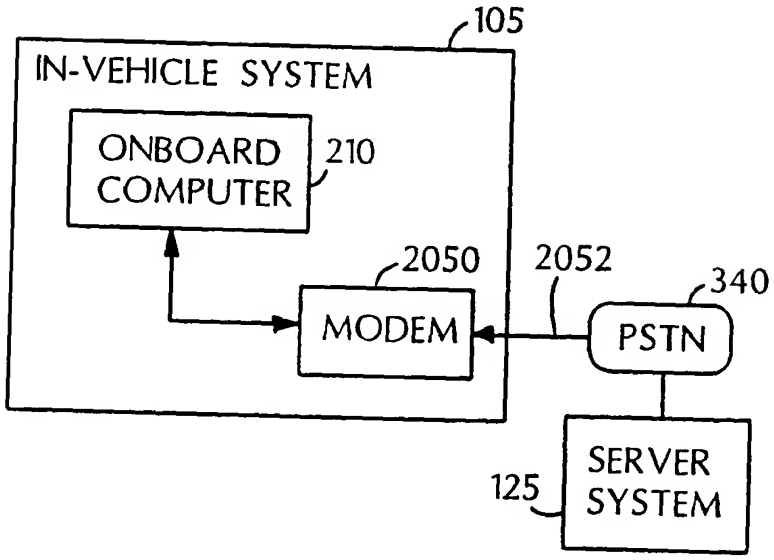

105
IN-VEHICLE SYSTEM
ONBOARD COMPUTER
210
2050
MODEM
2052
340
PSTN
SERVER SYSTEM
125

FIG. 20C

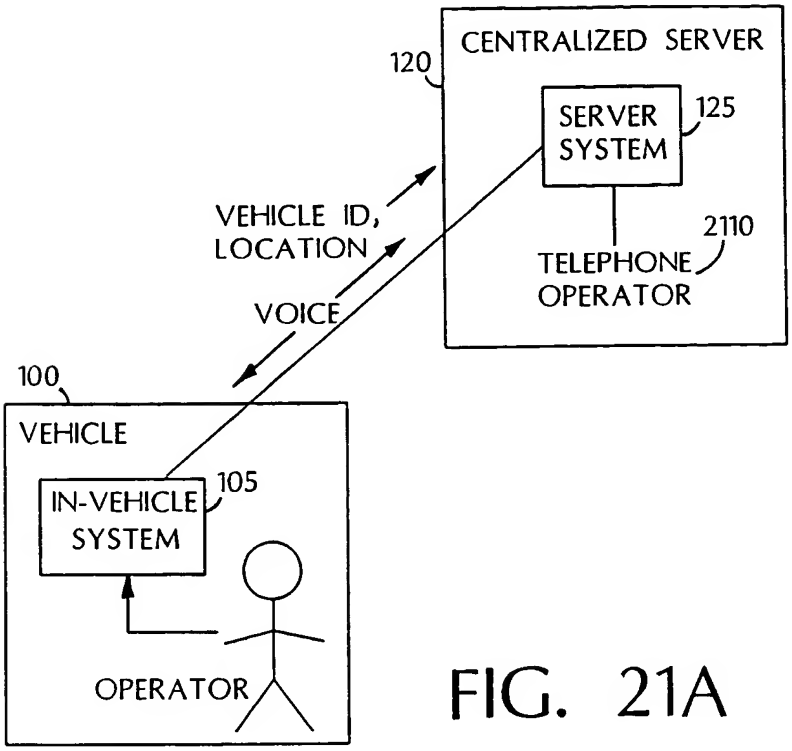
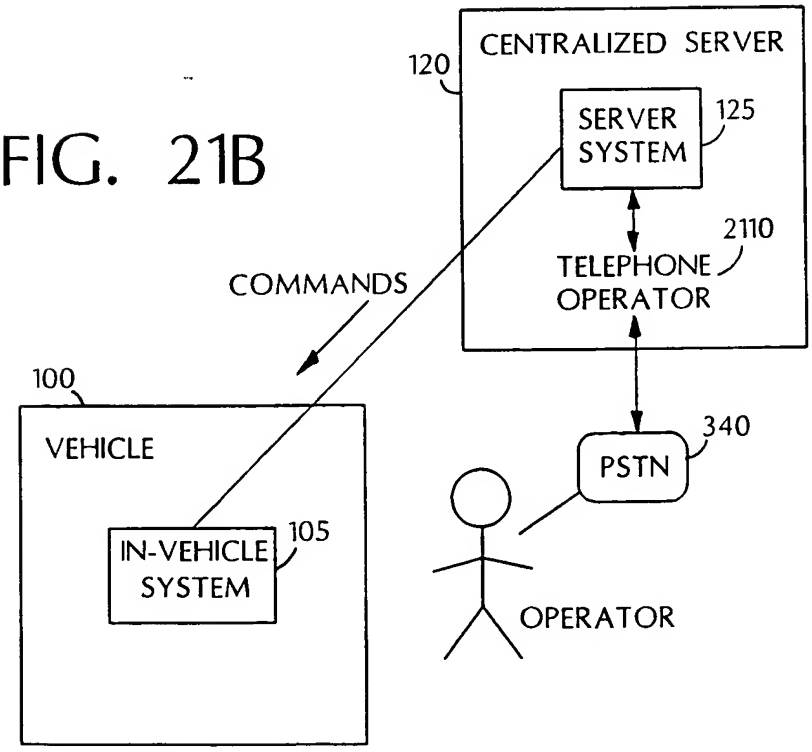


FIG. 21A

FIG. 21B



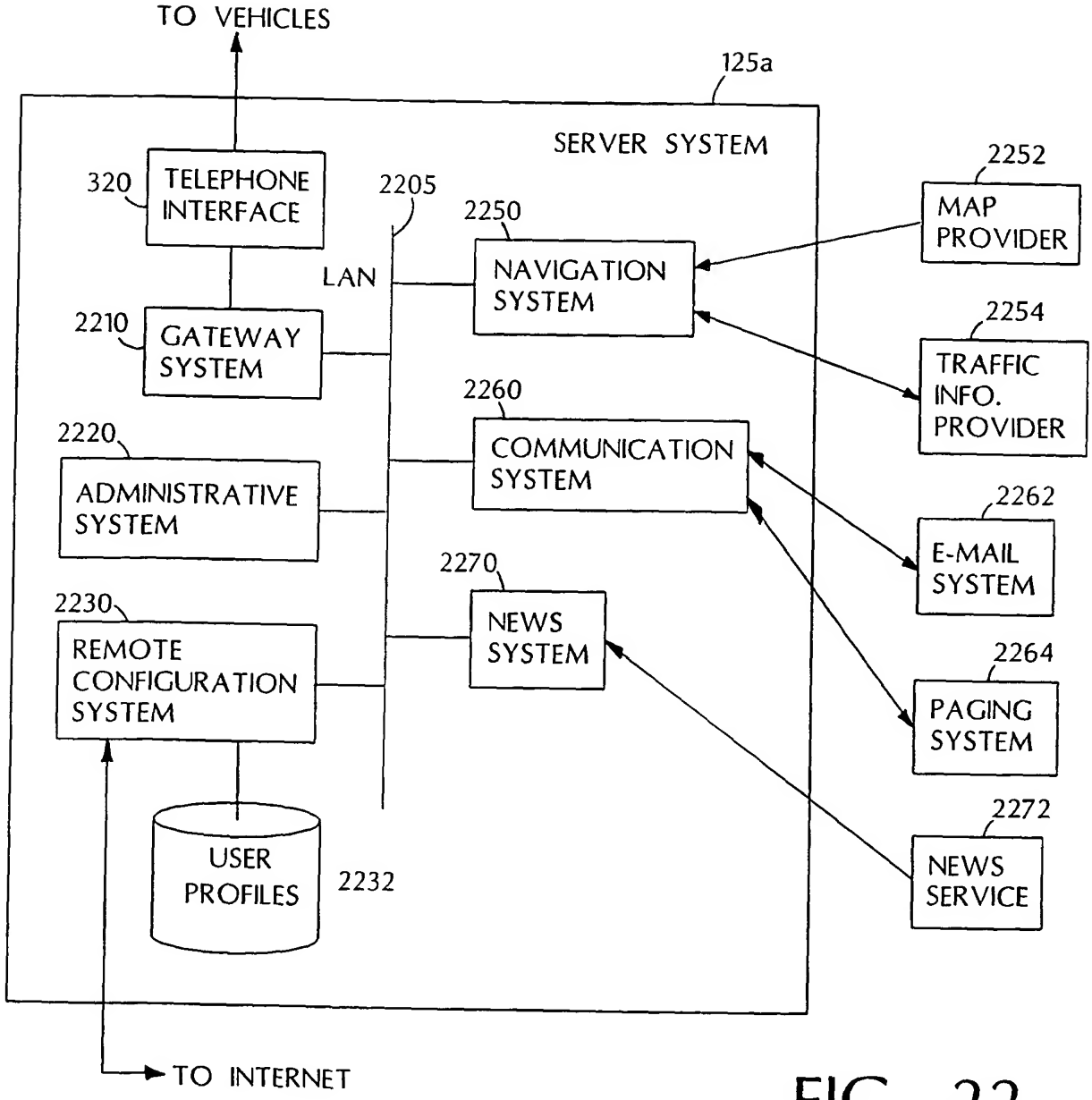

TO VEHICLES
125a
SERVER SYSTEM
320
TELEPHONE INTERFACE
2205
LAN
2250
NAVIGATION SYSTEM
2252
MAP PROVIDER
2210
GATEWAY SYSTEM
2254
TRAFFIC INFO. PROVIDER
2260
COMMUNICATION SYSTEM
2220
ADMINISTRATIVE SYSTEM
2262
E-MAIL SYSTEM
2270
NEWS SYSTEM
2230
REMOTE CONFIGURATION SYSTEM
2264
PAGING SYSTEM
2272
NEWS SERVICE
USER PROFILES
2232
TO INTERNET

FIG. 22